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TITLE: SCALE AND METHOD FOR PRODUCING THIS SCALE AND POSITION MEASURING SYSTEM EMPLOYING SUCH A SCALE

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SCALE AND METHOD FOR PRODUCING THIS SCALE AND POSITION MEASURING SYSTEM EMPLOYING SUCH A SCALE

[0001] Applicants claim, under 35 U.S.C. §119, the benefit of priority of the filing date of July 18, 2002 of a German patent application, copy attached, Serial Number 102 32 559.6, filed on the aforementioned date, the entire contents of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a scale, having magnetic elements of different magnetization, which are arranged in the measuring direction, and wherein the scale is put together from several base bodies, each base body having several of the magnetic elements on a non-magnetizable support, and wherein the magnetic elements of a base body are magnetized in a single identical direction, and the combined scale has alternatingly a magnetic element of one base body and a magnetic element of another base body in the measuring direction. The present invention furthermore relates to a method for producing such a scale. Finally, the present invention also relates to a position measuring system employing such a scale.

Discussion of Related Art

[0003] Scales of this type are employed in position measuring systems of processing machines for measuring the relative position of a tool with respect to a workpiece to be processed, as well as in coordinate-measuring machines for detecting the position and dimensions of test objects. In the course of this, the position measuring system can be

employed as a direct measuring system, i.e. installed directly on the components to be measured, or as an indirect measuring system, i.e. installed on the drive mechanisms (electrical drive motors). Further applications are found in connection with motor vehicles, for example as steering angle sensors, and in office communications.

[0004] A scale is known from EP 0 715 151 B1, which is formed by assembling two identical base bodies. Each one of these base bodies has several magnetic elements magnetized in the same direction. When assembled, the magnetic elements of the one base body lie in the spaces between the magnetic elements of the other base body, so that the scale alternatingly has a magnetic element of one body and of a further body in the measuring direction. In the assembled state, the magnetic elements of the one base body are magnetized in the opposite direction from the magnetic elements of the other base body.

[0005] For achieving a zero-symmetrical magnetic field at the surface to be scanned for a position measurement, it is proposed to injection-mold the magnetic elements onto a disk-shaped non- magnetic support by a dual-component injection-molding process.

[0006] However, this has the disadvantage that the non-magnetic support is arranged on a surface of the scale which is to be scanned, which results in a reduced magnetic field strength at the scanning location.

OBJECT AND SUMMARY OF THE INVENTION

[0007] It is therefore an object of the present invention to create a scale which is simple to manufacture and which generates the greatest possible magnetic field strength at the scanning location for a position measurement.

[0008] In accordance with the present invention, this object is attained by a scale that

includes a first base body having a first non-magnetizable support and a first set of magnetic elements that are arranged laterally next to the first non-magnetizable support, are magnetized in a single identical direction and are arranged in a measuring direction. A second base body having a second non-magnetizable support and a second set of magnetic elements that are arranged laterally next to the second non-magnetizable support, are magnetized in the single identical direction and area arranged in the measuring direction. The first base body and the second base body are put together such that in the measuring direction alternating ones of the first and second sets of magnetic elements are arranged and the first and second sets of magnetic elements have different magnetic orientations with respect to each other.

[0009] It is a further object of the present invention to disclose a method for producing such scales.

[0010] In accordance with the present invention, this object is attained by a method for producing a scale that includes providing a first base body having a first non-magnetizable support and a first set of magnetic elements that are arranged laterally next to the first non-magnetizable support, are magnetized in a single identical direction and are arranged in a measuring direction. Providing a second base body having a second non-magnetizable support and a second set of magnetic elements that are arranged laterally next to the second non-magnetizable support, are magnetized in the single identical direction and area arranged in the measuring direction. Combining the first base body with the second base body is accomplished by sticking them together such that in the measuring direction alternating ones of the first and second sets of magnetic elements are arranged and the first and second sets of magnetic elements have different magnetic orientations with respect to each other.

different magnetic orientations with respect to each other.

[0011] Moreover, a position measuring system is to be disclosed by the present invention, which is simply constructed and permits a dependable position measurement.

[0012] This object is attained by a position measuring system having a scale having a first base body including a first non-magnetizable support and a first set of magnetic elements that are arranged laterally next to the first non-magnetizable support, are magnetized in a single identical direction and are arranged in a measuring direction. A second base body including a second non-magnetizable support and a second set of magnetic elements that are arranged laterally next to the second non-magnetizable support, are magnetized in the single identical direction and area arranged in the measuring direction. The first base body and the second base body are put together such that in the measuring direction alternating ones of the first and second sets of magnetic elements are arranged and the first and second sets of magnetic elements have different magnetic orientations with respect to each other. A scanning element, which is sensitive to a magnetic field, for scanning the first and second sets of magnetic elements.

[0013] Exemplary embodiments of the present invention will be explained by the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a perspective plan view of an embodiment of a scale in accordance with the present invention;

[0015] FIG. 2 is a perspective plan view of embodiments of two axially magnetized

base bodies in the course of being assembled to form the scale of FIG. 1 in accordance with the present invention; and

[0016] FIG. 3 represents an embodiment of a position measuring system with a plurality of the scales of FIG. 1 in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] A scale embodied in accordance with the present invention will be explained by FIGS. 1 and 2 by the example of a coded disk 1 for an angle measuring device.

[0018] The coded disk 1 includes concentrically arranged code tracks, which are radially spaced apart from each other. Each code track has a sequence of magnetic elements 11, 21, 12, 22, which are arranged one behind the other in the measuring direction X (circumferential direction). The direction of magnetization of successive magnetic elements 11, 21, 12, 22 is differently oriented, in particular oppositely directed. Preferably the code tracks form a Gray code. For controlling an electric motor, the code tracks can also form commutation tracks, known per se.

[0019] The code tracks with the magnetic elements 11, 21, 12, 22 are spaced apart from each other in the radial direction, and concentric strips 15, 25 of a non-magnetic material extend in this interspace.

[0020] The coded disk 1 is put together from several base bodies 10, 20 as shown in FIG. 2. The magnetic elements 11, 12, 21, 22 of a base body 10, 20 are arranged laterally (viewed transversely to the measuring direction X) next to a non-magnetic strip-shaped support 15, 25. The thickness and axial position of the supports 15, 25 next to the magnetic elements 11, 12, 21, 22 has been selected to be such that,

following the assembly process represented in FIG. 2, the magnetic elements 11, 12 of the one base body 10 and the magnetic elements 21, 22 of the other base body 20 come to rest on a least one front surface at the same height, and therefore on a common plane, and do not interfere with each other during the assembly process.

[0021] The magnetic elements 11, 12, 21, 22 of a respective base body 10, 20 are axially magnetized in the same direction, which occurs in a single process step. The magnetization direction can also extend radially or in the measuring direction X. It is particularly advantageous if the two base bodies 10, 20 represented in FIG. 2 are identical, i.e. have the same geometric shape and the same magnetization. The coded disk with magnetic elements 11, 21, 12, 22 of different magnetization arranged in the measuring direction X, wherein one magnetic element 11, 12 of the one base body 10 enters between respectively two magnetic elements 21, 22 of the other base body 20, which follow each other in the measuring direction X, is only created by the assembly of the two base bodies 10, 20 in opposing directions, in that one of the base bodies is rotated by 180°. Therefore, in the measuring direction X the assembled coded disk 1 has magnet elements 11, 12 of a base body 10 alternating with magnetic elements 21, 22 of the other base body 20.

[0022] An advantage that the magnetic elements 11, 12, 21, 22 of a base body 10, 20 are each located next to a non-magnetic support 15, 25 can be seen to be that these supports 15, 25 cannot disadvantageously affect the magnetic fields of the magnetic elements 11, 12, 21, 22, but that yet satisfactory stability, and therefore a manipulation capability of the base bodies 10, 20 is assured. As can be seen in FIG. 1, the axial ends of the magnetic elements 11, 21, 12, 22 of the two base bodies 10, 20, i.e. the

alternatingly arranged north and south poles, are arranged in one plane and can therefore be scanned at a relatively short scanning distance by a scanning element 2 (Hall element or magneto- resistive resistance strip). No interfering support is located in the space between the magnetic elements 11, 12, 21, 22 and the scanning element 2. The support(s) 15, 25 is/are not arranged on the surface of the magnetic elements 11, 12, 21, 22 to be scanned, but exclusively laterally next to the surface of the magnetic elements 11, 12, 21, 22 to be scanned for a position measurement.

[0023] A base body 10, 20 is particularly advantageously produced by a dual-component injection-molding process by injecting two materials on top of each other, wherein the material constituting the support 15, 25 is not magnetizable. The material which constitutes the magnetic elements 11, 12, 21, 22 is a plastic material filled with magnetic or magnetizable substances.. Hard-magnetic materials in the form of neodymium-iron-boron (NdFeB), samarium-cobalt (SmCo) or ceramic magnets are preferably selected as the magnetizable substance, by which a high magnetic field strength can be realized. In this case an isotropic or an anisotropic production is possible. Polyamide (PA), for example, which can be fiberglass-reinforced, is used as the support material. To achieve a good bonding of the two materials, they are injected one shortly after the other into a mold, i.e. one of the materials is injected while the first injected material is still in the pasty state.

[0024] The support(s) 15, 25 of the base bodies 10, 20 can also be embodied as prefabricated non-magnetizable insertion elements, on which the magnetic elements 11, 12, 21, 22 are injection-molded. Here, the supports 15, 25 created in a first injection process can be used as insertion elements for the second injection process.

[0025] In summary, each base body 10, 20 is made in the same manner. For example, in the case of base body 10, the non-magnetized support 15 is first formed by an injection molding a non-magnetized material into a mold. After the support 15 is formed, the magnetic elements 11, 12 are simultaneously formed on the support 15 by injecting a magnetic material into the mold that contains the support 15 so that the base body of FIG. 2 is formed. The process can be reversed where the magnetic elements 11, 12 are simultaneously formed via first injecting the magnetic material into the mold so that the magnetic elements 11, 12 are formed. Next. the non-magnetized support 15 is formed on the magnetic elements 11, 12 by injecting the non-magnetizable material into the mold that contains the magnetic elements 11, 12. The end result of either process is that the support 15 is injection molded to the magnetic elements 11, 12 and the support 15 and magnetic elements 11, 12 are spatially next to each other as shown in FIG. 2.

[0026] If the scale 1 is intended to be used under high temperatures and is required to have a particularly great strength, a castable magnetic material AlNiCo or iron-chromium- cobalt (such as the material manufactured under the trademark Crovac by Vacuumschmelze GmbH & Co., KG of Hanau, Germany) is employed as the magnetic material. In that case the non-magnetic support 15, 25 preferably consists of a castable non-magnetizable metal.

[0027] The area of use of the scales 1 embodied in accordance with the present invention is with incremental or absolute angle or linear measuring systems. Here, the magnetic elements 11, 12, 21, 22 can be arranged in only one track, but advantageously in several tracks.

[0028] A particularly advantageous employment of the coded disk 1 in accordance with the present invention is represented in FIG. 3 by a multi-turn angle encoder. In such an angle measuring system, a coded disk 4 is fastened on an input shaft 3 for measuring the position within one revolution of the input shaft 3. This coded disk 4 is scanned by a scanning device 5. For picking up the number of revolutions, several identical coded disks 1 embodied in accordance with the present invention are driven by the input shaft 3 via reduction gears 6.

[0029] Further exemplary embodiments exist within the scope of the present invention besides the described examples.